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Large stadium spatial layout and its function positioning study

Jianbao Jiang, Ju Liu
Institute of Physical Education, Ningbo University, Ningbo 315211, Zhejiang, (CHINA)

ABSTRACT

Sports service industry is an important affiliated enterprise of sports industry, and also an indispensible industry of a nation economy, Chinese sports service industry present situation is not going well; therefore, the paper analyzes Chinese sports service industry, and makes strategy study on future development. Honeycomb model is regional coverage model, the paper centers on large stadium, by its coverage range, makes joint efforts to build layout and positioning on urban area large stadium. Utilize analytic hierarchy process model, the paper gets that for China densely populated cities, stadiums proportions are 74.4%, which indicates stadiums have higher advantages in occupation of land, construction investment, equipment investment, economic gains, city planning, convenience degree, fitness benefits and other aspects.

KEYWORDS

Large stadium; Honeycomb model; Analytic hierarchy process.

INTRODUCTION

By city economic rapidly development, except for constructing corresponding housing estate sports facilities, cities also have lots of high-ranking stadiums, sports clubs and so on.

As following Figure shows, Figure is city sports fields' amount.

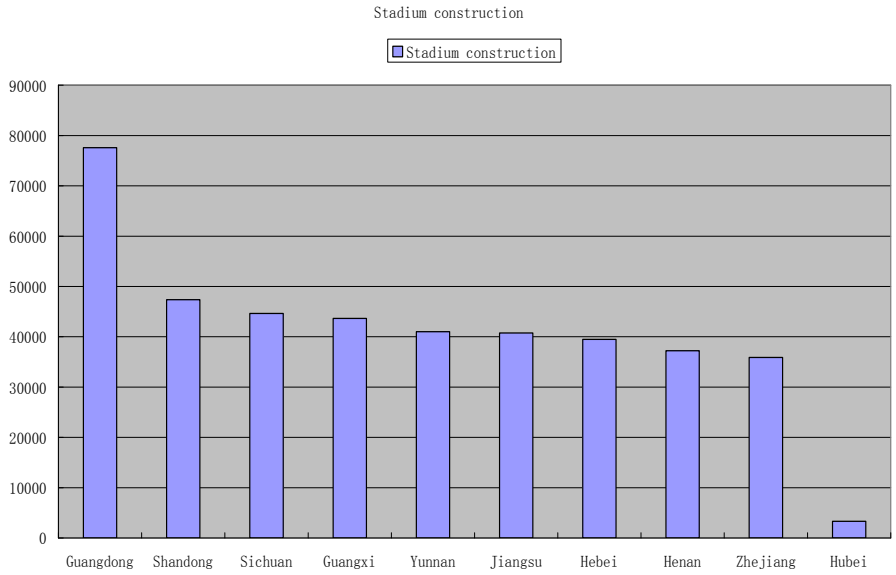


Figure 1 : City sports fields' amount

TABLE 1 : Sports service industry proportion in sports industry

Province	Guangdong	Jiangsu	Beijing	Liaoning	Zhejiang
Proportion	24%	15%	30%	13%	15%

By TABLE 1, it is clear that for economic rapidly developed cites, their sports service industry is also developed, which shows sports service industry as an important backbone of economy is an indispensible industry of a country.

MODEL ESTABLISHMENT

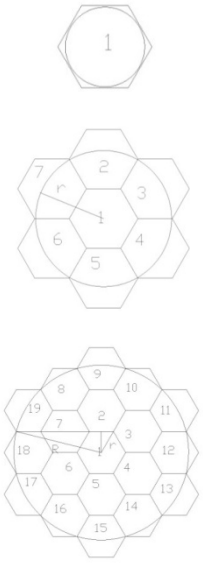
Honeycomb model

We only need to consider how to use small round to cover big round and let small round quantity to be minimum, assume all users are balanced distributed in round regions, and don't suffer landform, geomorphology, climate changes and other factors influences; Sports service needy, in view of number of people, due to coverage region is a round. Assume radiation radius r is the same; calculate three shapes housing estates neighboring region distances, housing estate area, crossover region width and crossover region area as TABLE 2 show.

TABLE 2 : Three kinds of graphs comparison

Housing estate shape	Regular triangle	Square	Regular Hexagon
Neighboring region distances	r	$\sqrt{2}r$	$\sqrt{3}r$
Housing estate area	$1.3r^2$	$2r^2$	$2.6r^2$
Crossover region width	r	$0.59r$	$0.27r$
Crossover region area	$1.2\pi r^2$	$0.73\pi r^2$	$0.35\pi r^2$

From the TABLE,it is clear that regular hexagon shape is the nearest ideal round, it can effective meet cover region, which is most proper, so that takes regular hexagon center as honeycomb structure,extends outside, it process as following show:



Among them, we can find diameter d and number N relationships:

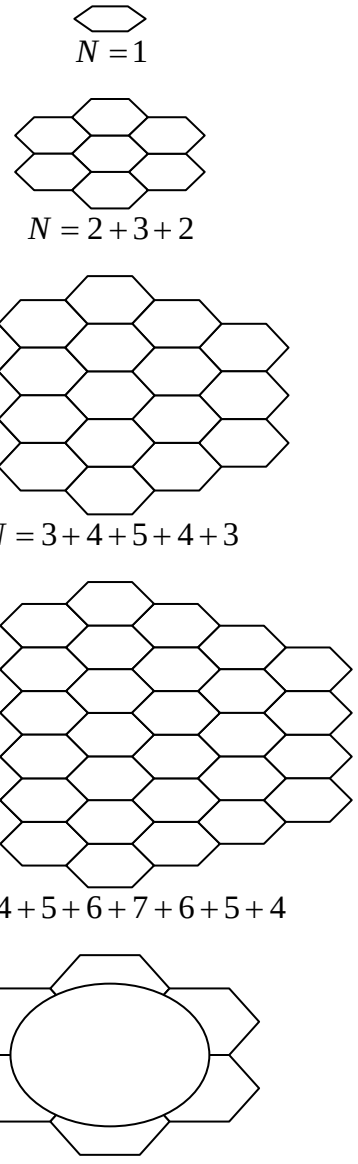


Figure 2 : Hexagon round region border

As Figure 2 show, round region border lies in the outermost layer hexagon center, it can get by rules that:

$$N = 12n^2 + 30n + 19$$

Among them, N is overspread round region required numbers of hexagons. n is equal to:

$$n = \frac{D}{d}$$

Among them, D is round region diameter, d is hexagon inscribed circle diameter.

Assume in round region with radius as 40 miles, use least quantity of stadiums to accommodate users and meanwhile operate. Every stadium contains a fixed coverage range, and stadium coverage range will change followed by number of people density extent changes, to get optimal coverage result, it should arrive at every adjacent two stadiums coverage ranges to achieve minimum overlapping area. The paper makes statistics of these data into TABLE, as TABLE 3 shows.

TABLE 3 : Statistical table

Number of sports facilities or stadiums N	Coverage radius r	Number of sports facilities or stadiums N	Coverage radius r
1	40	1834	1.559
7	20	1453	1.118
19	11.09	1519	1.801
39	8	1456	1.567
65	7.154	1354	1.568
98	6.667	1456	1.478
134	5.298	2456	1.454
171	5	2269	1.428
217	4.193	2453	1.355
271	4	2645	1.333
315	3.468	2784	1.269
358	3.333	2925	1.25
457	2.957	3153	1.194
587	2.857	3452	1.176
628	2.577	3671	1.126
738	2.5	3581	1.111
845	2.283	3997	1.066
945	2.222	4219	1.053
1037	2.049	4457	1.012
1237	2	4845	1

By stadiums available coverage regions and overlapping areas, it should consider population density extent, due to city population is more concentrated, though a stadium or sports facility group can meet certain regions' sports public service demand, it cannot let the regions citizen can freely and smoothly enjoy sports public services, so, it should consider population density extent, properly increase overlapping areas, similarly, for sparsely population or economy relative backward regions, stadium coverage area should expand, otherwise it will cause resources waste and enterprise elimination status.

Sports service industry serves to different group of people, they have different consumption views. Economic developed cities have higher requirements on sports service industry. But countryside and towns areas required sports services grades are lower, otherwise it will cause resource waste and resource irrational arrangement. And different recognition and concepts on sports service industry are also important factors that restrict uneven regional consumption level. Therefore, for Chinese sports service industry, urban and rural economic imbalanced development is an important factor that up to sports service industry distribution.

Establish AHP hierarchical analysis structure

Establish target layer, criterion layer and scheme layer relations.

Target layer : Selection of large stadium

Criterion layer : scheme influence factors, economic loss B_1, cultural benefits B_2

Scheme layer : occupation of land C_1, construction investment C_2, equipment investment C_3, fitness benefits C_4, economic gains C_5, city planning C_6, convenience degree C_7.

The paper establishes criterion layer from seven aspects, and establishes AHP hierarchical structure as Figure 3.

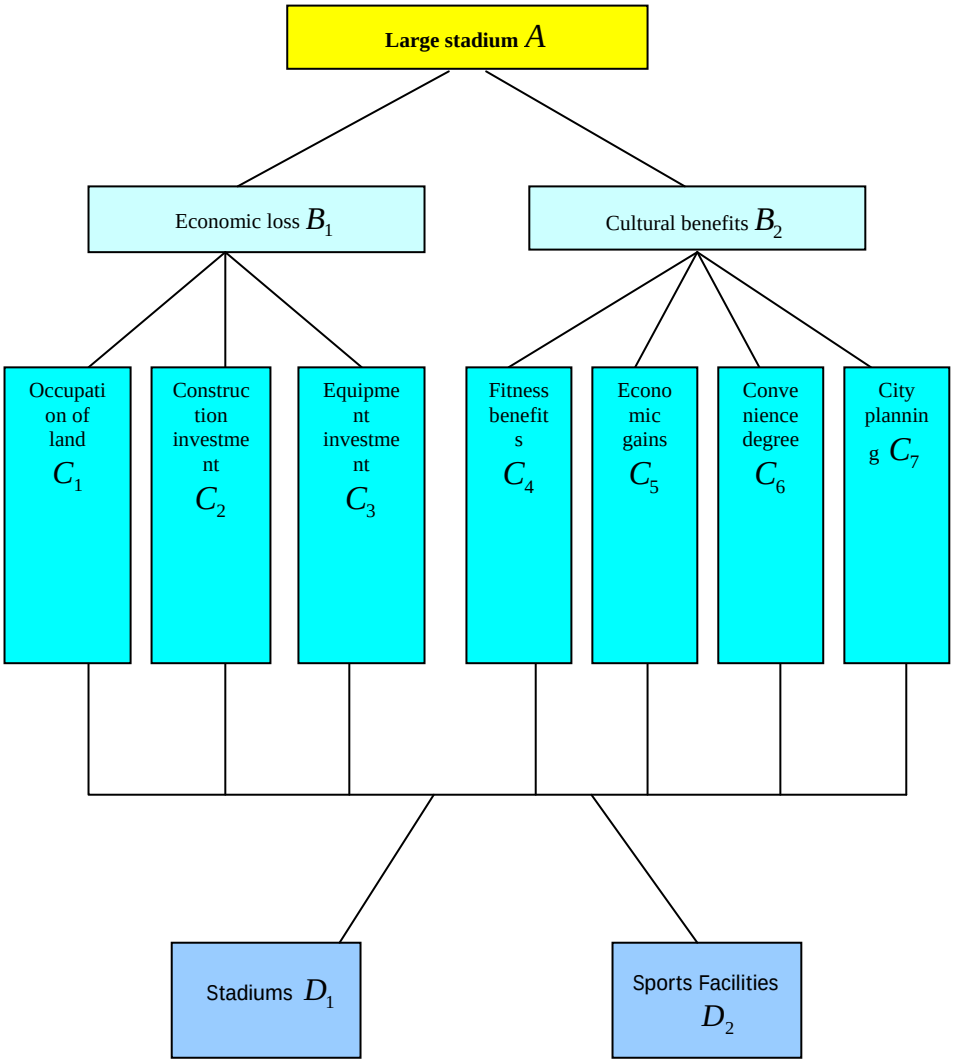


Figure 3 : AHP **hierarchical structure**

Weighted assignment accords to weights represented definitions, applies paired comparison method, it gets relative weights and forms into paired comparison matrixes.

$\alpha_{ij} = 1, \frac{1}{2}, \ldots, \frac{1}{9}$ represents C_i and C_j importance that is opposite to above Figure, and $\alpha_{ji} = \frac{1}{\alpha_{ij}}$

According to experience suggestions, carry out paired comparison of criterion layer and scheme layer with previous layer every element. Criterion layer B to target layer A judgment matrix :

$$A = (\alpha_{ij})_{n \times n}$$

Calculate judgment matrix feature vector (hierarchical single arrangement):

G corresponding maximum feature root $\lambda_{\max}$ feature vector ω is weight vector , then $A\omega = \lambda_{\max}\omega$,it solves weight vector ω, and lets every line to divide arithmetic mean to make normalization. Set

$$\omega = (w)_{n \times 1}$$

$$\omega_1^{'} = \frac{\omega_1}{\sum_{i=1}^{n} \omega_i} (i = 1,2,...,n)$$

Consistency indicator

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

Random consistency indicator is RI, consistency ratio

$$CR = \frac{CI}{RI}$$

When $CR < 0.1$, it meets consistency test, analysis result is correct.

Calculate combination weight (Hierarchical total arrangement)

Assume criterion layer B 2 elements B_1 B_2 total arrangement fulfills, corresponding weights are β_1, β_2. Criterion layer C 7 elements $C_1, C_2, ..., C_7$, then single arrangement result that corresponds to previous layer factor $A_j (j = 1,2)$ is $\gamma_{1j}, \gamma_{2j}, ..., \gamma_{3j}$ scheme layer D, single arrangement results to previous layer factor C_M are δ_{1m}, δ_{2m}, then corresponding combination weight

$$w_i = \sum_{j=1}^{2} \sum_{m=1}^{7} \delta_{im} \gamma_{mj} \beta_j (i = 1,2)$$

According to the method, calculate scheme layer to target layer combination weight. When order number $n \le 2$, matrix always has completely consistency. Solved weights are as TABLE 4, 5 shows.

TABLE 4 : Simple sports facilities empowerment system

Target layer	Criterion layer	Criterion layer
Reasonable sports service industry distribution	Economic loss 0.75	Occupation of land
		Construction investment
		Equipment investment
	Cultural benefits 0.25	Fitness benefits
		Economic gains
		City planning
		Convenience degree

TABLE 5 : High-ranking stadium empowerment system

Target layer	Criterion layer	Criterion layer
Reasonable sports service industry distribution	Economic loss 0.75	Occupation of land
		Construction investment
		Equipment investment
	Cultural benefits 0.25	Fitness benefits
		Economic gains
		City planning
		Convenience degree

By calculating, it gets weight.

$w_1 = 0.256$,

$w_2 = 0.744$

Obtained result shows high-ranking stadium gained proportion is larger.

CONCLUSION

Economic developed cities have higher requirements on sports service industry. But countryside and towns areas required sports services grades are lower, if follow high-ranking stadium requirements, it will cause resource waste and resource irrational arrangement. And different recognition and concepts on sports service industry are also important factors that restrict uneven regional consumption level. Chinese sports service industry has many drawbacks, as earlier starting, lower starting point, imbalanced development, but overall trend is increasing by year. Sports service industry serves to different group of people, they have different consumption views. Therefore, for Chinese sports service industry, urban and rural economic imbalanced development is an important factor that up to sports service industry distribution. For Chinese densely populated cities, stadiums proportions are 74.4%, which indicates stadiums have higher advantages in occupation of land, construction investment, equipment investment, economic gains, city planning, convenience degree, fitness benefits and other aspects.

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